Tumor-Vessel Relationships in Pancreatic Ductal Adenocarcinoma at Multidetector CT: Different Classification Systems and Their Influence on Treatment Planning

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Jeffrey Klein, MD  Welcome to our RadioGraphics podcast. I’m Jeff Klein Editor of RadioGraphics and today we are pleased to have with us the senior author of our paper that is entitled “Tumor-Vessel Relationships in Pancreatic Adenocarcinoma: Different Classification Systems and Their Influence on Treatment Planning, A Guide for the Radiologist” which appears in the current January 2017 issue of the journal. I’m pleased to welcome today Dr. Atif Zaheer who is an Associate Professor in the Russell H. Morgan Department of Radiology and Radiological Science at John Hopkins Medical Institutions in Baltimore, Maryland. So let’s get started. Dr. Zaheer your paper details the use of multidetector CT in pancreatic ductal adenocarcinoma to identify those patients with borderline resectable disease defined by limited arterial involvement and/or reconstructible portovenous involvement. Based on this definition and the key to performing and interpreting these multidetector CT studies is the assessment of the circumferential and longitudinal involvement of the tumor with the adjacent vasculature. You begin your published review of this subject with a description of the multidetector CT protocol that you use at your institution for evaluating these patients. You also touch on use of MR and PET CT in this setting as well. Can you review for us the technique that you use and how you perform your multidetector CT studies to evaluate these patients?

Atif Zaheer, MD  Well Dr. Klein thank you for having me. It’s a pleasure to be here. The protocol, CT protocol, is very standard at most institutions. We start off with the dual-phase CT which is arterial and venous phase, so the arterial phase is acquired at about 30 to 35 seconds after the injection of intravenous contrast, iodinated contrast, and then the venous phase is about 60 seconds. So the arterial phase is good to assess the arterial anatomy and also the pancreas parenchyma. The venous phase is good to assess for liver metastases and any metastatic disease elsewhere and of course the venous anatomy. We use water as a negative oral contrast and the injection rate is about 4 to 5 cc per second. I think we use the 3 mm slices for our primary view and then we use the thinner slices to do multiplanar reconstruction. Those are really the key because they really help us assess the subtle changes in the vascular anatomy and also assess for the presence of variant anatomy and how the vessels are really impacted by the tumor.

J.K.  So Atif could you review for us just briefly the staging of pancreatic ductal adenocarcinoma for our viewers and in particular the characterization of what is considered to be resectable, borderline resectable, and locally advanced, and obviously metastatic disease so we have some framework as to what we’re discussing today?

A.Z.  The staging system of the American Joint Committee on Cancer is the most widely used so it’s divided into four stages. Stage one is basically when the tumor is less than 2 cm and stage two when it’s any size but does not involve any adjacent vessels. These are the clearly resectable tumors. Stage four on the other hand is the other extreme, you have metastatic disease and these patients derive no benefit from resection of the tumor. Now stage three is the interesting one which is subdivided into something that is locally advanced pancreatic cancer and where there’s encasement of one or more major vessels and the venous involvement that is not reconstructable or resectable. The fourth category which is the second category of stage three is the most interesting one because it is the borderline resectable disease and this is where the tumor abuts a major vessel. It could be an artery or a vein and it is reconstructable or resectable, so that’s what we really focus on in this paper.

J.K.  I see. So let’s now focus if we can on the multidetector CT assessment of the portovenous involvement. Portovenous involvement is not, from my understanding, an absolute contraindication to surgical resection, but there are findings on CT that are highly suggestive of portal vein and SNV tumor infiltration. Can you take us through Figure 4 in the paper which illustrates an important finding that’s associated with this assessment?

A.Z.  Sure. The tumor involvement of the vein is assessed in two different ways. Firstly, based on the tumor vein circumferential interface which predicts the probability of vascular invasion. For instance if you have greater than 180 degree contact with the vessel, then there’s an 80% probability of a vascular invasion. If you have completely tumor encasement then there’s a 100% probability that the vessels are invaded. The second way which is basically what’s described in this figure is described by is by Ishikawaga and colleagues. It’s a very interesting idea in which they describe the relationship between the pancreatic tumor and the nearby vessels based on the vein caliber and the length of interface as it predicts the surgical outcomes. So for example if you have a normal caliber vein or if you have just a smooth shift of the vein by the mass effect on the tumor, or if you have unilat-
eral narrowing, and then if you have less than 1.2 cm of the cranial portal extension of the tumor then you have more favorable surgical outcomes as opposed to a patient who has a bilateral narrowing of the vein or collateral vein formation because of the narrowing. So this really emphasizes the need for the assessment of multiplanar reformations because then you can really assess the craniocaudal extent of the tumor in multiple planes and see how far it extends and affects the vein caliber.

J.K. Sure. So now your paper goes into quite a bit of detail on the evaluation of abutment versus encasement, particularly the celiac and the hepatic arterial access and the SMA and you provide a diagram in the paper which I believe is Figure 12 that illustrates this. And then Figure 13 very nicely shows sort of the preoperative and the postoperative CT evaluation of the common hepatic arterial and the gastroduodenal arterial involvement by tumor. Can you take us through case 13 and just describe what it illustrates?

A.Z. Again this figure illustrates a very important point because the tumors that arise in the neck of the pancreas they frequently involve the celiac artery and common hepatic artery proximal to the original gastroduodenal artery and these can be resected because if there is a patent or uninvolved gastroduodenal artery it can retain the profusion to the liver. So distal pancreatectomy and splenectomy is done in these patients and this procedure is also known as the modified Appleby procedure. In this case when you see that the gastroduodenal artery is unaffected and that can be assessed intraoperatively as well when you clamp the common hepatic artery and assess for pulsation in the proper hepatic artery. So if there are pulsation, if there is good enough supply and by an uninvolved gastroduodenal artery to the liver then there is no need to resect the whole area and actually you can have the liver be supplied by the gastroduodenal artery. In this case you can see that this tumor abutting the common hepatic artery, the preoperative maximum intensity projection image shows an uninvolved gastroduodenal artery and the post-op image shows that there’s successful resection and then the profusion to the liver is maintained nicely by the gastroduodenal artery. This is done by the superior mesenteric artery and pancreatic duodenal arcade.

J.K. Thank you. Towards the end of the paper you describe the multidetector CT evaluation of borderline resectable patients who have received neoadjuvant treatment prior to surgical resection. I know Dr. Lillemoe and his accompanying commentary with this paper points out that there are some limitations in the radiologic analysis of the tumor response to neoadjuvant treatment which you readily acknowledge in the paper. But can you show us this case which is Figure 21 that nice illustrates the use of multidetector CT in the neoadjuvant setting?

A.Z. As you said the radiologic evaluation after neoadjuvant therapy still remains a challenge. Studies have shown that there is a lack of association between change in tumor size and postoperative outcomes, and there’s decreased specificity in determining the margin negative resectability due to overestimation of the tumor size on CT. There was an interesting study by Cossinotto and colleagues in 2014 that showed a correlation between decrease in tumor vessel circumferential contact and the rate of negative resection margin with high specificity and positive predictor value. In this figure you see here, there was near complete occlusion of the portal vein by the tumor, and after neoadjuvant therapy it regained its complete patency and the patient had surgically negative margins in this case.

J.K. Terrific. Finally, your paper discusses at the end the use of template-based reporting to improve the documentation of findings and the descriptors that define the relationship between the tumor and vessel which really should help our communications as radiologists with surgeons and for that matter with patients whose finding – these findings may impact their management. In Table 4 you provide a list of some of these reporting parameters, do you use these as a template in the reporting of your CT studies in these patients?

A.Z. As you know that the template-based reporting we’ve had significant success when it comes to prostate cancer, breast imaging and musculoskeletal imaging. The standardized template that was provided by the multi-institutional group of pancreatic cancer experts is an excellent one. It provides a very comprehensive detailed evaluation of the patients who have pancreatic cancer. The reasons we’ve had limited success with it is because the – well two major reasons. One is that the template can be a little rigid so people wanted to have the fluidity of expression in their reports. The other thing is that it can be time consuming right, so if you had a template you want to make sure that everything is filled out as opposed to just like a half filled out template. That’s why we’ve had limited success. What we were trying to do was simplify it even more so all the key factors are still described without going into the nauseating details of everything that may or may not be useful for a patient.

J.K. Sure understood. I’d like to thank Dr. Zaheer for joining us today to discuss his group’s paper again with appears in the current January 2017 issue of RadioGraphics.

A.Z. Thank you for having me.

J.K. Thank you very much.